Agency: Commerce, Community and Economic Development
Grants to Named Recipients (AS 37.05.316)
Grant Recipient: Alaska Resource Agency **Federal Tax ID:** 45-0709876

Project Title: **Project Type:** Remodel, Reconstruction and Upgrades

Alaska Resource Agency - Biomass Research & Emission Reduction

State Funding Requested: $500,000 **House District:** Fairbanks Areawide (7-11)
Future Funding May Be Requested

Brief Project Description:

Pursuant to §40 CFR Part 51 and AS 46.14.020, reduce energy costs and particulate emissions of home and commerical solid fuel heating devices through upgrade or replacement.

Funding Plan:

Total Project Cost:	$500,000
Funding Already Secured:	($0)
FY2012 State Funding Request:	($500,000)
Project Deficit:	$0

Funding Details:
NA

Detailed Project Description and Justification:

This appropriation is intended for biomass/biofuel energy technological advancement. Specifically, it is for the research, development, manufacturing, and installation of pollution control devices (particularly for boilers/stoves), or improved solid fuel heating devices, to reduce particulate matter emissions in accordance with EPA guidelines. It is also intended to assist in the DEC education campaign related to proper use of outdoor wood boilers and woodstoves to improve device efficiency and prevent nuisance emissions. Lastly, this grant is intended to assist with emission inspection, and training necessary for ongoing maintenance, of boilers/stoves when devices are used as a primary or secondary heat source.

This capital project addresses an immediate public health concern and is necessary to meet the EPA's air quality mandate and avoid the consequence of non-compliance with the federal Clean Air Act-- which may lead to the denial of various federal transportation funds and diversion of federal military deployments/funding. EPA designated an Interior "non-attainment" area pursuant to 40 CFR Part 51 (Clean Air Fine Particle Implementation Rule, Federal Register, Vol. 72, No. 79, pgs 20594-20596, 20621).

While reduced boiler/stove emissions render an attractive cost-effective alternative to other heating sources (esp. while enduring the high cost of fuel), it is a public interest to promote proper use of solid fuel devices and provide the best technology available to affirm the intertwined necessity for affordable heat and clean emissions.

Alaska Resource Agency spearheaded the deployment of patented pollution control devices in Alaska--devices that also reduce residential energy consumption/costs by extending the life of boilers and maximizing BTU useage. While the

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research and installation of these devices positively effects the Fairbanks North Star Borough, other rural communities will also benefit from advanced hydronic heater development and expanding the 'fire prevention' paradigm developed in Tok (i.e. using wood bioenergy for both energy efficiency and cleaning-up "slash" wood susceptible to forest fire).

Expenditure categories:

By DEC, municipal, and CCHRC estimates, the following quantity exists for catalyst upgrade or replacement within the Interior non-attainment area: Approximately 30 known hydronic heaters; ~4,500 woodstoves and ~12 coal burning devices. Additionally, homes may benefit, in energy efficiency, from an accessory heat exchanger attachment to an existing home heating device. Besides the cost of the devices and installation (and development of devices), funding can be used for device & emission inspection, and training & materials to promote best operating procedures.

Whereas the EPA mandated a strict timeline for decreasing emissions, this project can begin within one month of funding availability (Fall 2011).

Project Timeline:

Expenditures are expected to occur within the first month of availability in summer 2011. The sequence and priority of expenditures are outdoor wood boiler upgrades with existing NESCAUM certified/tested catalysts and development of an indoor stove catalyst so upgrades can continue through Winter 2012.

Entity Responsible for the Ongoing Operation and Maintenance of this Project:

Alaska Resource Agency

Grant Recipient Contact Information:

Name:	W. Saller
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	Anchorage, Alaska 99503
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Has this project been through a public review process at the local level and is it a community priority? [X] Yes [ ] No

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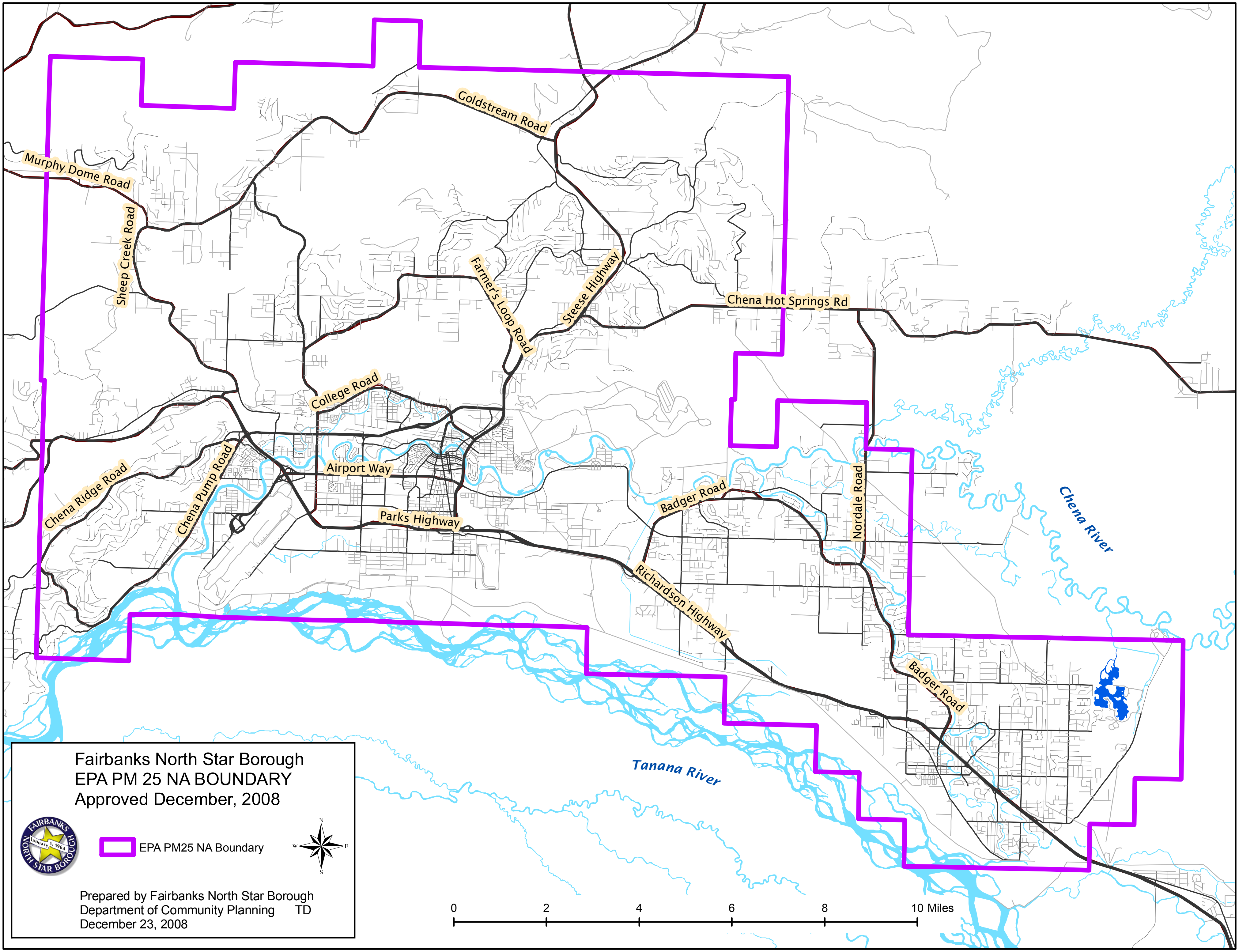
Fairbanks North Star Borough
EPA PM 25 NA BOUNDARY
Approved December, 2008
EPA PM25 NA Boundary
Prepared by Fairbanks North Star Borough
Department of Community Planning TD
December 23, 2008
0
2
4
6
8
10 Miles
Goldstream Road
Murphy Dome Road
Sheep Creek Road
Farmer's Loop Road
Steese Highway
Chena Hot Springs Rd
College Road
Airport Way
Chena Ridge Road
Chena Pump Road
Parks Highway
Badger Road
Nordale Road
Richardson Highway
Badger Road
Chena River
Tanana River

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STATE OF ALASKA
DEPARTMENT OF HEALTH AND SOCIAL SERVICES

Press Release

COMMISSIONER'S OFFICE

FOR IMMEDIATE RELEASE: August 30, 2010

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Study connects Fairbanks hospitalization rates to air quality

Hospital numbers tracked over five years

(Anchorage, AK) — A study published today by the State of Alaska Section of Epidemiology reveals a correlation between an increase in certain hospitalizations and an increase in the concentration of tiny atmospheric particles in the Fairbanks North Star Borough.

The study, based on five years of records from Fairbanks Memorial Hospital, examined 5,718 hospital visits for conditions related to heart disease, stroke and respiratory illness following periods of higher than average amounts of particulate matter smaller than 2.5 microns, known as $PM_{2.5}$. $PM_{2.5}$ are produced by combustion from car engines, power plants, and wood stoves. The study revealed that each 10 microgram per cubic meter increase in $PM_{2.5}$ resulted in a:

- 7 percent increased risk for a stroke-related hospital visit for people under age 65;
- 6 percent increased risk for a stroke-related hospital visit for people 65 or older; and
- 6 percent increased risk for a respiratory illness-related hospital visit for people under age 65.

"Basically, this study re-affirms what has already been demonstrated in similar studies performed outside of Alaska," said Rachel Kossover, the epidemiologist who authored the study. "People with heart and lung problems need to take air-quality warnings seriously and follow the advice of local officials."

Air quality information for the Fairbanks North Star Borough is available by telephone at 907-459-1312, or online at: http://www.co.fairbanks.ak.us/airquality/.

A copy of the study is available at: http://www.epi.alaska.gov/bulletins/docs/b2010_26.pdf

A fact sheet is also available at:
http://www.epi.alaska.gov/eh/airquality/FairbanksAirQualityStudyFactSheet.pdf

# # #

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precursor for that area. This approach will provide for regulation of VOCs in locations where it is most appropriate.

Comment: One commenter suggested that EPA wait for the results of the pending agricultural emissions study before requiring control of VOCs in agricultural areas.

Response: The $15 million national CAFO consent agreement study coordinated by Purdue University will greatly improve ammonia and VOC emissions inventories and our understanding of the impacts of agricultural emissions on particle formation. The EPA recognizes that the agricultural emissions study is expected to provide data for future planning purposes, and we expect that some of the results of the study will not be available in time to be considered in the development of $PM_{2.5}$ State Implementation Plans dues in April 2008. However, if a State believes it has sufficient technical information to warrant regulation of VOC emissions in their 2008 implementation plans, it may include in its plan a demonstration to reverse the presumption as well as emission reduction measures. The EPA will review each submittal on a case-by-case basis.

5. Policy for NO_X

[Section II.E.2 of November 1, 2005 proposed rule (70 FR 65999); sec. 51.1002 in draft and final regulatory text.]

a. Background

The sources of NO_X are numerous and widespread. The combustion of fossil fuel in boilers for commercial and industrial power generation and in mobile source engines each account for approximately 30 percent of NO_X emissions in $PM_{2.5}$ nonattainment areas (based on 2001 emission inventory information). Nitrates are formed from the oxidation of oxides of nitrogen into nitric acid either during the daytime (reaction with OH) or during the night (reactions with ozone and water). Nitric acid continuously transfers between the gas and the condensed phases through condensation and evaporation processes in the atmosphere. However, unless it reacts with other species (such as ammonia, sea salt, or dust) to form a neutralized salt, it will volatilize and not be measured using standard $PM_{2.5}$ measurement techniques. The formation of aerosol ammonium nitrate is favored by the availability of ammonia, low temperatures, and high relative humidity. Because ammonium nitrate is semivolatile and not stable in higher temperatures, nitrate levels are typically lower in the summer months and higher in the winter months. The resulting ammonium nitrate is usually in the sub-micrometer particle size range. Reactions with sea salt and dust lead to the formation of nitrates in coarse particles. Nitric acid may be dissolved in ambient aerosol particles.

Based on a review of speciated monitoring data analyses, it is apparent that nitrate concentrations vary significantly across the country. For example, in some southeastern locations, annual average nitrate levels are in the range of 6 to 8 percent of total $PM_{2.5}$ mass, whereas nitrate comprises 40 percent or more of $PM_{2.5}$ mass in certain California locations. Nitrate formation is favored by the availability of ammonia, low temperatures, and high relative humidity. It is also dependent upon the relative degree of nearby SO_2 emissions because ammonia reacts preferentially with SO_2 over NO_X. NO_X reductions are expected to reduce $PM_{2.5}$ concentrations in most areas. However, it has been suggested that in a limited number of areas, NO_X control would result in increased $PM_{2.5}$ mass by disrupting the ozone cycle and leading to increased oxidation of SO_2 to form sulfate particles, which are heavier than nitrate particles. Because of the above factors, the proposed rule presumed that States must evaluate and implement reasonable controls on sources of NO_X in all nonattainment areas, but allowed for the State and EPA to develop a technical demonstration to reverse this presumption.

b. Final Rule

The EPA is retaining the proposed approach in the final rule.[13] Under this policy, States are required to address NO_X as a $PM_{2.5}$ attainment plan precursor and evaluate reasonable controls for NO_X in $PM_{2.5}$ attainment plans, unless the State and EPA make a finding that NO_X emissions from sources in the State do not significantly contribute to $PM_{2.5}$ concentrations in the relevant nonattainment area. This presumptive policy is consistent with other recent EPA regulations requiring NO_X reductions which will reduce fine particle pollution, such as the Clean Air Interstate Rule and a number of rules targeting onroad and nonroad engine emissions.

Technical demonstrations that would reverse the presumption should be developed in advance of the attainment demonstration and are discussed in section II.A.8 below.

[13] The policy is the same as proposed, with the clarification regarding downwind areas discussed above (Section A.2.b).

c. Comments and Responses

Comment: Most commenters generally agreed with the proposed inclusion of NO_X as a presumptive $PM_{2.5}$ attainment plan precursor.

Response: The EPA agrees with these commenters.

Comment: Some commenters requested guidance on what would constitute an acceptable demonstration to reverse the presumption that NO_X is a $PM_{2.5}$ attainment plan precursor.

Response: Guidance on technical demonstrations to reverse the presumptive inclusion of NO_X in all state implementation plans is discussed in section II.A.8 below.

Comment: One commenter raised concerns that the proposed policy for NO_X would allow a State to find NO_X to be an insignificant contributor to an area's $PM_{2.5}$ nonattainment problem and effectively keep the State from controlling the area's NO_X emissions for other purposes, such as to address interstate transport under section 110 of the CAA. Section 110 requires SIPs to prohibit emissions within the State that would contribute significantly to another State's nonattainment problem or interfere with another State's maintenance plan.

Response: The identification of precursors for regulation under this rule is for purposes of $PM_{2.5}$ nonattainment and maintenance plans under Part D of the CAA. The $PM_{2.5}$ implementation rule does not prevent a State from regulating NO_X sources under any other Federal or State rule, including interstate transport rules under Section 110.

6. Policy for SO_2

[Section II.E.2 of November 1, 2005 proposed rule (70 FR 65999); sec. 51.1002 in draft and final regulatory text.]

a. Background

Sulfur dioxide is emitted mostly from the combustion of fossil fuels in boilers operated by electric utilities and other industry. Less than 20 percent of SO_2 emissions nationwide are from other sources, mainly other industrial processes such as oil refining and pulp and paper production. The formation of sulfuric acid from the oxidation of SO_2 is an important process affecting most areas in North America. There are three different pathways for this transformation.

First, gaseous SO_2 can be oxidized by the hydroxyl radical (OH) to create sulfuric acid. This gaseous SO_2 oxidation reaction occurs slowly and only in the daytime. Second, SO_2 can controlling emissions of direct particulate matter and PM precursors.

As discussed in section II.J.5. above, EPA recognizes that control technology guidance for certain source categories has not been updated for many years. Section 183(c) of the CAA, which addresses control technologies to address ozone nonattainment problems, requires EPA to ''revise and update such documents as the Administrator determines necessary.'' As new or updated information becomes available States should consider the new information in their RACT determinations. A State should consider the new information in any RACT determinations or certifications that have not been issued by the State as of the time such updated information becomes available.

Stationary Source Measures

—Stationary diesel engine retrofit, rebuild or replacement, with catalyzed particle filter

—New or upgraded emission control requirements for direct $PM_{2.5}$ emissions at stationary sources (e.g., installation or improved performance of control devices such as a baghouse or electrostatic precipitator; revised opacity standard; improved compliance monitoring methods)

—Improved capture of particulate emissions to increase the amount of $PM_{2.5}$ ducted to control devices, and to minimize the amount of $PM_{2.5}$ emitted to the atmosphere, for example, through roof monitors

—New or upgraded emission controls for $PM_{2.5}$ precursors at stationary sources (e.g., SO_2 controls such as wet or dry scrubbers, or reduced sulfur content in fuel; desulfurization of coke oven gas at coke ovens; improved sulfur recovery at refineries; increasing the recovery efficiency at sulfuric acid plants)

—Energy efficiency measures to reduce fuel consumption and associated pollutant emissions (either from local sources or distant power providers)

—Measures to reduce fugitive dust from industrial sites

Mobile Source Measures

—Onroad diesel engine retrofits for school buses,[34] trucks and transit buses using EPA-verified technologies

—Nonroad diesel engine retrofit, rebuild or replacement, with catalyzed particle filter [35]

—Diesel idling programs for trucks, locomotive, and other mobile sources [36]

—Transportation control measures (including those listed in section 108(f) of the CAA as well as other TCMs), as well as other transportation demand management and transportation systems management strategies [37]

—Programs to reduce emissions or accelerate retirement of high emitting vehicles, boats, and lawn and garden equipment

—Emissions testing and repair/maintenance programs for onroad vehicles

—Emissions testing and repair/maintenance programs for nonroad heavy-duty vehicles and equipment [38]

—Programs to expand use of clean burning fuels [39]

—Low emissions specifications for equipment or fuel used for large construction contracts, industrial facilities, ship yards, airports, and public or private vehicle fleets

—Opacity or other emissions standards for ''gross-emitting'' diesel equipment or vessels

Area Source Measures

—New open burning regulations and/or measures to improve program effectiveness such as programs to reduce or eliminate burning of land clearing vegetation

—Programs to reduce emissions from woodstoves and fireplaces including outreach programs, curtailments during days with expected high ambient levels of $PM_{2.5}$, and programs to encourage replacement of woodstoves when houses are sold

—Controls on emissions from charbroiling or other commercial cooking operations

—Reduced solvent usage or solvent substitution (particularly for organic compounds with 7 carbon atoms or more, such as toluene, xylene, and trimethyl benzene)

Category-Specific Guidelines on innovative approaches. The EPA has issued a number of category specific guidelines on approaches to taking into account innovative approaches to emissions reductions for purposes of SIPs. Categories currently covered by these guidelines include: (1) Electric-sector Energy Efficiency and Renewable Energy Measures; (2) Long Duration Switch Yard Locomotive Idling; (3) Long Duration Truck Idling; (4) Clean Diesel Combustion Technology; and (5) Commuter Choice Programs. See *http://www.epa.gov/ttn/airinnovations/measure_specific.html.*

c. Comments and Responses

Comment: Some commenters recommended that EPA provide new CTGs or other control technology review documents for purposes of assisting States to address $PM_{2.5}$ and its precursors, because the information in some current documents is out-dated.

Response: The EPA recognizes that issuance of new or updated CTGs specifically tailored for $PM_{2.5}$ would be useful. Unfortunately, limitations on time and resources preclude EPA from developing such CTGs in advance of the SIP submission date. The EPA cannot delay the statutorily specified outer date for SIP submission. However, EPA believes that there are already many sources of information and guidance on key source categories. To the extent that States need to examine potential control measures for sources never addressed before in any area or other context for a previous NAAQS, EPA anticipates that it will work closely with States during the process of plan development and approval to ensure an appropriate approach.

Comment: A number of commenters expressed concerns with references to the STAPPA and ALAPCO *Menu of Options* document. Some commenters believed that this document must be subject to formal review and comment to ensure appropriate stakeholder input.

Response: The language in the final preamble has been changed to refer to a Web site EPA maintains that provides access to a variety of information sources regarding control technologies that may be useful to States to consider in developing their $PM_{2.5}$ SIPs. These links include evaluations developed by government and nongovernment organizations. One such source with potentially useful information is the STAPPA and ALAPCO *Menu of Options.* However, EPA is not specifically endorsing any of the specific evaluations as being appropriate in any specific situation. Rather, we think documents such as the

[34] See Clean School Bus USA program at *http://www.epa.gov/cleanschoolbus/.* See also: ''What You Should Know About Diesel Exhaust and School Bus Idling,'' (June 2003, EPA420–F–03–021) at *http://www.epa.gov/otaq/retrofit/documents/f03021.pdf.*

[35] See EPA's voluntary diesel retrofit program Web site at *http://www.epa.gov/otaq/retrofit/overfleetowner.htm.*

[36] See EPA's voluntary diesel retrofit program Web site at *http://www.epa.gov/otaq/retrofit/idling.htm.*

[37] See EPA's Web site on transportation control measures at *http://www.epa.gov/otaq/transp/traqtcms.htm.*

[38] See EPA's Web site on nonroad engines, equipment, and vehicles at *http://www.epa.gov/otaq/nonroad.htm.*

[39] Fuels adopted in SIPs must be consistent with the Energy Policy Act of 2005 and EPA guidance on SIP-approved boutique fuels at 71 FR 78192 (December 28, 2006).

dissolve in cloud water (or fog or rain water), and there it can be oxidized to sulfuric acid by a variety of oxidants, or through catalysis by transition metals such as manganese or iron. If ammonia is present and taken up by the water droplet, then ammonium sulfate will form as a precipitate in the water droplet. After the cloud changes and the droplet evaporates, the sulfuric acid or ammonium sulfate remains in the atmosphere as a particle. This aqueous phase production process involving oxidants can be very fast; in some cases all the available SO_2 can be oxidized in less than an hour. Third, SO_2 can be oxidized in reactions in the particle-bound water in the aerosol particles themselves. This process takes place continuously, but only produces appreciable sulfate in alkaline (dust, sea salt) coarse particles. Oxidation of SO_2 has also been observed on the surfaces of black carbon and metal oxide particles. During the last 20 years, much progress has been made in understanding the first two major pathways, but some important questions still remain about the smaller third pathway. Models indicate that more than half of the sulfuric acid in the eastern United States and in the overall atmosphere is produced in clouds.

The sulfuric acid formed from the above pathways reacts readily with ammonia to form ammonium sulfate, $(NH_4)_2SO_4$. If there is not enough ammonia present to fully neutralize the produced sulfuric acid (one molecule of sulfuric acid requires two molecules of ammonia), part of it exists as ammonium bisulfate, NH_4HSO_4 (one molecule of sulfuric acid and one molecule of ammonia) and the particles are more acidic than ammonium sulfate. In certain situations (in the absence of sufficient ammonia for neutralization), sulfate can exist in particles as sulfuric acid, H_2SO_4. Sulfuric acid often exists in the plumes of stacks where SO_2, SO_3, and water vapor are in much higher concentrations than in the ambient atmosphere, but these concentrations become quite small as the plume is cooled and diluted by mixing.

Because sulfate is a significant contributor (e.g. ranging from 9 percent to 40 percent) to $PM_{2.5}$ concentrations in nonattainment areas and to other air quality problems in all regions of the country, EPA proposed that States would be required to address sulfur dioxide as a $PM_{2.5}$ attainment plan precursor in all areas.

b. Final Rule

The final rule includes the same policy for sulfur dioxide as in the proposal. States are required to address sulfur dioxide as a $PM_{2.5}$ attainment plan precursor and evaluate SO_2 for possible control measures in all areas. Sulfate is an important precursor to $PM_{2.5}$ formation in all areas, and has a strong regional impact on $PM_{2.5}$ concentrations. This policy is consistent with past EPA regulations, such as the CAIR, the Clean Air Visibility Rule, the Acid Rain rules, and the Regional Haze rule, that require SO_2 reductions to address fine particle pollution and related air quality problems.

Under the transportation conformity program, sulfur dioxide is not required to be addressed in transportation conformity determinations *before* a SIP is submitted unless either the state air agency or EPA regional office makes a finding that on-road emissions of sulfur dioxide are significant contributors to the area's $PM_{2.5}$ problem. Sulfur dioxide would be addressed *after* a $PM_{2.5}$ SIP is submitted if the area's SIP contains an adequate or approved motor vehicle emissions budget for sulfur dioxide. EPA based this decision on the *de minimis* level of sulfur dioxide emissions from on-road vehicles currently, and took into consideration the fact that sulfur dioxide emissions from on-road sources will decline in the future due to the implementation of requirements for low sulfur gasoline (which began in 2004) and for low sulfur diesel fuel (beginning in 2006). For more information, see the May 6, 2005 transportation conformity rule on $PM_{2.5}$ precursors at 70 FR 24283.

c. Comments and Responses

Comment: Most commenters agreed with the proposed policy for SO_2. One commenter stated, ''* * * requiring states to address sulfur dioxide in attainment planning in all areas is consistent with the science of $PM_{2.5}$ formation and essential to effective implementation of the $PM_{2.5}$ NAAQS.'' Another commenter concluded that EPA's proposal ''* * * is justified based on the fact that SO_2 has been found to be a significant contributor to $PM_{2.5}$ nonattainment in all areas.''

Response: The EPA agrees with these comments.

Comment: Some commenters believe States should be able to make a demonstration that SO_2 not be addressed as an attainment plan precursor. The commenters claim that the urban increment of sulfate is generally small, and SO_2 control will not matter in many areas. Commenters also note that a large percentage of the SO_2 emission inventory is being reduced and will be reduced further through existing programs, and that if attainment can be demonstrated without additional SO_2 controls, a State should be allowed to make that demonstration in its SIP. One commenter stated that whether SO_2 emissions from a given source located in a nonattainment area in fact contribute significantly to ambient concentrations of sulfate and $PM_{2.5}$ in that nonattainment area likely will depend on a range of factors, including source type, stack height, location, and meteorology. The commenter asserted that sulfate forms over significant geographic distances from the source of the SO_2 emissions and may not form significant concentrations of $PM_{2.5}$ in the local nonattainment area.

Response: As in the proposal, the final rule requires SO_2 to be considered a $PM_{2.5}$ attainment plan precursor in all cases. Sulfate is a significant fraction of $PM_{2.5}$ mass in all nonattainment areas currently, and although large SO_2 reductions are projected from electric generating units with the implementation of the CAIR program, sulfate is still projected to be a key contributor to $PM_{2.5}$ concentrations in the future. SO_2 emissions also lead to sulfate formation on both regional and local scales. The EPA agrees that the extent of the contribution from a particular source in a nonattainment area to $PM_{2.5}$ concentrations in the area will depend on a number of factors, and that at times the reaction of SO_2 emissions in the atmosphere to form sulfate particles may occur less rapidly and extend over a significant distance. However, at other times the conversion of SO_2 to sulfate can occur rapidly and local impacts from a particular source can be more significant. States are required to develop plans to attain as expeditiously as practicable through the identification of technically and economically feasible control measures from the full range of source categories contributing to $PM_{2.5}$ nonattainment areas. In developing these plans, each State will need to consider whether controls on local SO_2 sources would be cost-effective and would be needed to attain expeditiously.

7. Policy for Direct PM

[Section II.E.2 of November 1, 2005 proposed rule (70 FR 65999); sec. 51.1002 in draft and final regulatory text.]

a. Background

This section addresses inorganic and organic forms of directly emitted PM. Although these direct emissions are by definition not precursors to $PM_{2.5}$, this section is included to provide information on the full range of components that commonly make up fine particulate matter.

The main anthropogenic sources of inorganic (or crustal) particles are: entrainment by vehicular traffic on unpaved or paved roads; mechanical disturbance of soil by highway, commercial, and residential construction; and agricultural field operations (tilling, planting and harvesting). Industrial processes such as quarries, minerals processing, and agricultural crop processing can also emit crustal materials. While much of these emissions are coarse PM, the size distribution can have a tail of particles smaller than $PM_{2.5}$.

In general, coarse PM is most important close to the source, and not generally a significant contributor to regional scale PM problems. Even so, during certain high wind events, fine crustal PM has been shown to be transported over very long distances.

Emission estimates of mechanically suspended crustal PM from sources within the U.S. are often quite high. However, this PM is often released very close to the ground, and with the exception of windblown dust events, thermal or turbulent forces sufficient to lift and transport these particles very far from their source are not usually present. Thus, crustal material is only a minor part of $PM_{2.5}$ annual average concentrations.

Primary carbonaceous particles are largely the result of incomplete combustion of fossil or biomass fuels. This incomplete combustion usually results in emissions of both black carbon and organic carbon particles. High molecular weight organic molecules (i.e., molecules with 25 or more carbon atoms) are either emitted as solid or liquid particles, or as gases that rapidly condense into particle form. These heavy organic molecules sometimes are referred to as volatile organic compounds, but because their characteristics are most like direct PM emissions, they will be considered to be primary emissions for the purposes of this regulation. Primary organic carbon also can be formed by condensation of semi-volatile compounds on the surface of other particles.

The main combustion sources emitting carbonaceous $PM_{2.5}$ are certain industrial processes, managed burning, wildland fires, open burning of waste, residential wood combustion, coal and oil-burning boilers (utility, commercial and industrial), and mobile sources (both onroad and nonroad). Certain organic particles also come from natural sources such as decomposition or crushing of plant detritus. Most combustion processes emit more organic particles than black carbon particles. A notable exception to this is diesel engines, which typically emit more black carbon particles than organic carbon. Because photochemistry is typically reduced in the cooler winter months for much of the country, studies indicate that the carbon fraction of PM mass in the winter months is likely dominated by direct PM emissions as opposed to secondarily formed organic aerosol.

Particles from the earth's crust may contain a combination of metallic oxides and biogenic organic matter. The combustion of surface debris will likely entrain some soil. Additionally, emissions from many processes and from the combustion of fossil fuels contain elements that are chemically similar to soil. Thus, a portion of the emissions from combustion activities may be classified as crustal in a compositional analysis of ambient $PM_{2.5}$. The proposed rule required that States address the direct emissions of particulate matter in their $PM_{2.5}$ attainment plans. During the comment period, EPA received several comments regarding the definition of what should be regulated as ''direct $PM_{2.5}$.''

b. Final Rule

This rule defines direct $PM_{2.5}$ emissions as ''air pollutant emissions of direct fine particulate matter, including organic carbon, elemental carbon, direct sulfate, direct nitrate, and miscellaneous inorganic material (i.e. crustal material).'' Development of attainment plans will include direct $PM_{2.5}$ emissions and specific $PM_{2.5}$ attainment plan precursors.

c. Comments and Responses

Comment: A few commenters noted that 40 CFR 51.1000 of the proposed rule includes definitions for both ''direct $PM_{2.5}$ emissions'' and for ''$PM_{2.5}$ direct emissions.'' They recommend including just one definition in the final rule.

Response: The EPA acknowledges this oversight and has included in the final rule a single definition for ''direct $PM_{2.5}$ emissions.'' It reads: ''Direct $PM_{2.5}$ emissions means solid particles emitted directly from an air emissions source or activity, or gaseous emissions or liquid droplets from an air emissions source or activity which condense to form particulate matter at ambient temperatures. Direct $PM_{2.5}$ emissions include elemental carbon, directly emitted organic carbon, directly emitted sulfate, directly emitted nitrate, and other inorganic particles (including but not limited to crustal material, metals, and sea salt).''

8. Optional Technical Demonstrations for NO_X, VOC, and Ammonia

[Section II.E.2 of November 1, 2005 proposed rule (70 FR 65999); sec. 51.1002 in draft and final regulatory text.]

a. Background

The proposed rule required States to evaluate and consider control strategies for sources of SO_2 and direct $PM_{2.5}$ emissions in all nonattainment areas. For the precursors NO_X, VOC, and ammonia, the proposed rule included presumptive policies that could be reversed with an acceptable technical demonstration by the State or EPA. (The policy in the proposal presumptively required that NO_X emissions must be addressed in all areas, and that VOC and ammonia emissions do not need to be addressed in all areas.) A number of commenters requested additional guidance on the criteria for an acceptable technical demonstration.

b. Final Rule

The final rule retains provisions for the State or EPA to conduct a technical demonstration to reverse the presumptive inclusion of NO_X or to reverse the presumptive exclusions of ammonia and VOC as $PM_{2.5}$ attainment plan precursors. Demonstrations to reverse the presumptions for ammonia, VOC, or NO_X are to be based on the weight of evidence of available information, and any demonstration by the State must be approved by EPA. The State must demonstrate that based on the sum of available technical and scientific information, it would be appropriate for a nonattainment area to reverse the presumptive approach for a particular precursor. The demonstration should include information from multiple sources, including results of speciation data analyses, air quality modeling studies, chemical tracer studies, emission inventories, or special intensive measurement studies to evaluate specific atmospheric chemistry in an area.

Because of the variation among nonattainment areas in terms of such factors as local emissions sources, growth patterns, topography, and severity of the nonattainment problem, EPA believes that it would not be appropriate to define a prescriptive set of analyses that must be included in all $PM_{2.5}$ precursor technical demonstrations. The key criterion is that any technical demonstration must fairly represent available information.

In developing the implementation plan for a nonattainment area, the State should use all relevant information

§ 49.125 Rule for limiting the emissions of particulate matter.

(a) *What is the purpose of this section?* This section limits the amount of particulate matter that may be emitted from certain air pollution sources operating within the Indian reservation to control ground-level concentrations of particulate matter.

(b) *Who is affected by this section?* This section applies to any person who owns or operates an air pollution source that emits, or could emit, particulate matter to the atmosphere, unless exempted in paragraph (c) of this section.

(c) *What is exempted from this section?* This section does not apply to woodwaste burners, furnaces and boilers used exclusively for space heating with a rated heat input capacity of less than 400,000 British thermal units (Btu) per hour, non-commercial smoke houses, sweat houses or lodges, open burning, and mobile sources.

(d) *What are the particulate matter limits for air pollution sources?* (1) Particulate matter emissions from a combustion source stack (except for wood-fired boilers) must not exceed an average of 0.23 grams per dry standard cubic meter (0.1 grains per dry standard cubic foot), corrected to seven percent oxygen, during any three-hour period.

(2) Particulate matter emissions from a wood-fired boiler stack must not exceed an average of 0.46 grams per dry standard cubic meter (0.2 grains per dry standard cubic foot), corrected to seven percent oxygen, during any three-hour period.

(3) Particulate matter emissions from a process source stack, or any other stack not subject to paragraph (d)(1) or (d)(2) of this section, must not exceed an average of 0.23 grams per dry standard cubic meter (0.1 grains per dry standard cubic foot) during any three-hour period.

(e) *What is the reference method for determining compliance?* The reference method for determining compliance with the particulate matter limits is EPA Method 5. A complete description of this method is found in appendix A of 40 CFR part 60.

(f) *Definitions of terms used in this section.* The following terms that are used in this section are defined in §49.123 General provisions: Act, air pollutant, air pollution source, ambient air, British thermal unit (Btu), coal, combustion source, distillate fuel oil, emission, fuel, fuel oil, gaseous fuel, heat input, incinerator, marine vessel, mobile sources, motor vehicle, nonroad engine, nonroad vehicle, open burning, particulate matter, PM10, PM2.5, process source, reference method, refuse, residual fuel oil, solid fuel, stack, standard conditions, stationary source, uncombined water, used oil, wood, wood-fired boiler, and woodwaste burner.

Title 40: Protection of Environment

§ 49.126 Rule for limiting fugitive particulate matter emissions.

(a) *What is the purpose of this section?* This section limits the amount of fugitive particulate matter that may be emitted from certain air pollution sources operating within the Indian reservation to control ground-level concentrations of particulate matter.

(b) *Who is affected by this section?* This section applies to any person who owns or operates a source of fugitive particulate matter emissions.

(c) *What is exempted from this section?* This section does not apply to open burning, agricultural activities, forestry and silvicultural activities, sweat houses or lodges, non-commercial smoke houses, public roads owned or maintained by any Federal, Tribal, State, or local government, or activities associated with single-family residences or residential buildings with four or fewer dwelling units.

(d) *What are the requirements for sources of fugitive particulate matter emissions?* (1) The owner or operator of any source of fugitive particulate matter emissions, including any source or activity engaged in materials handling or storage, construction, demolition, or any other operation that is or may be a source of fugitive particulate matter emissions, must take all reasonable precautions to prevent fugitive particulate matter emissions and must maintain and operate the source to minimize fugitive particulate matter emissions.

(2) Reasonable precautions include, but are not limited to the following:

(i) Use, where possible, of water or chemicals for control of dust in the demolition of buildings or structures, construction operations, grading of roads, or clearing of land.

(ii) Application of asphalt, oil (but not used oil), water, or other suitable chemicals on unpaved roads, materials stockpiles, and other surfaces that can create airborne dust.

(iii) Full or partial enclosure of materials stockpiles in cases where application of oil, water, or chemicals is not sufficient or appropriate to prevent particulate matter from becoming airborne.

(iv) Implementation of good housekeeping practices to avoid or minimize the accumulation of dusty materials that have the potential to become airborne, and the prompt cleanup of spilled or accumulated materials.

(v) Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials.

(vi) Adequate containment during sandblasting or other similar operations.

(vii) Covering, at all times when in motion, open bodied trucks transporting materials likely to become airborne.

(viii) The prompt removal from paved streets of earth or other material that does or may become airborne.

(e) *Are there additional requirements that must be met?* (1) A person subject to this section must:

(i) Annually survey the air pollution source(s) during typical operating conditions and meteorological conditions conducive to producing fugitive dust to determine the sources of fugitive particulate matter emissions. For new sources or new operations, a survey must be conducted within 30 days after commencing operation. Document the results of the survey, including the date and time of the survey and identification of any sources of fugitive particulate matter emissions found.

(ii) If sources of fugitive particulate matter emissions are present, determine the reasonable precautions that will be taken to prevent fugitive particulate matter emissions.

(iii) Prepare, and update as necessary following each survey, a written plan that specifies the reasonable precautions that will be taken and the procedures to be followed to prevent fugitive particulate matter emissions, including appropriate monitoring and recordkeeping. For construction or demolition activities, a written plan must be prepared prior to commencing construction or demolition.

(iv) Implement the written plan, and maintain and operate the source to minimize fugitive particulate matter emissions.

(v) Maintain records for five years that document the surveys and the reasonable precautions that were taken to prevent fugitive particulate matter emissions.

(2) The Regional Administrator may require specific actions to prevent fugitive particulate matter emissions, or impose conditions to maintain and operate the air pollution source to minimize fugitive particulate matter emissions, in a permit to construct or a permit to operate for the source.

(3) Efforts to comply with this section cannot be used as a reason for not complying with other applicable laws and ordinances.

(f) *Definitions of terms used in this section.* The following terms that are used in this section are defined in §49.123 General provisions: Agricultural activities, air pollutant, air pollution source, ambient air, emission, forestry or silvicultural activities, fugitive dust, fugitive particulate matter, owner or operator, particulate matter, permit to construct, permit to operate, PM10, PM2.5, Regional Administrator, source, stack, and uncombined water.

AS 46.14.020. Classification of Stationary Sources or Emissions Units; Reporting.

(a) The department, by regulation, may classify stationary sources or emissions units that, in the department's determination, are likely to cause or contribute to air pollution, according to the levels and types of emissions and other characteristics that relate to air quality. The department may make a classification under this subsection applicable to the state as a whole or to a designated area of the state. The department shall base the classifications on consideration of health, economic, and social factors, sensitivity of the receiving environment, and physical effects on property.

(b) The department or a local air quality control program authorized under AS 46.14.400 may require an owner and operator of a stationary source or emissions unit classified under this section to report information to the department or the authorized local program concerning location, size, and height of stacks or area emissions units, processes employed, fuels used, the nature and time periods or duration of emissions, and other information relevant to air quality that is available or reasonably capable of being calculated and compiled.

Project Funding / Budget

1. Four (4) wood stoves and materials necessary to customize testing facility: $112,000
2. Material costs and expenses for alpha prototypes: $55,000
3. Labor cost for design, installation and testing of alpha prototype units: $60,000
4. Material cost for six (6) 6” inside diameter beta prototypes: $39,000
5. Legal and administrative fees: $40,000
6. Travel expenses: $25,500
7. Installation in Alaska labor cost and support material: $28,500
8. Project Management fee: $86,000

Unit Cost Model

Calculated unit cost based on labor expense being equal and discounts based on supplier discounts passed through due to higher volume of raw materials purchased. ***Precious metals used in the catalyst are subject to market fluctuation. Pricing subject to change based on study outcome.***

Description Per Unit Cost (6”) Per Unit Support and Warranty

First 6 prototypes: $1,500.00 $7/month

7-100 units: $1,350.00 $7/month

100-1,000: $1,200.00 $7/month

1,000 – 5,000: $1,000.00 $7/month

CS-100 UNITS Per Unit Cost Per Unit Support and Warranty

First 50: $5,395.00 $10/month

50-100: $4,555.00 $10/month

100-1,000: $4,034.00 $10/month

1,000 – 5,000: $2,915.00 $10/month

Unit Installation Model

Calculated unit installation cost based on being at the site. Travel to and from the site will be on a time and materials basis. Driving will be at the current IRS rate. Flights will be based on the lowest possible price booked two weeks prior to the installation. The Fairbanks/North Pole area will be used as the starting point.

Description Installation Per 8" section of pipe

First 4' Section*: $100.00

4' Section 2-3: $100.00

Section 4**: $400.00

Section 5-10: $100.00

* Provided the OWF owner has dismantled the stack this would be the minimum charge for installation

**The fourth section of pipe will usually require the rental of a lift to safely remove the pipe. The $400 price is based on a $300 daily rental fee. Delivery of the lift and variability in rental fees could increase this charge.

1. Travel and expenses to support training and installation: $150,000
2. Sixty (60) USB data loggers for data collection project: $36,000
3. Labor for monthly data collection and inspection of units for six (6) months: $318,000
4. Quarterly data analysis and reporting (six months): $4,000

Project Funding / Budget

Build two (2) ~ 250,000 BTU prototype OWFs based on native Alaskan wood: $20,000.

Build serviceable catalyst prototype modules: $8,000.

Experiment with design concepts to deal with moisture capture: $15,000

Expand our intelligent controller to manage the OWF: $15,000

Rental of workspace and utilities North Pole fabrication facility: $3,000

Labor cost for design, installation and testing of prototype units: $20,000

Legal and administrative fees: $1,000

Travel and lodging expenses: $12,000

Project management fee: $16,000

sierra research

Report No. SR2010-06-01

2010 Fairbanks Home Heating Survey

prepared for:

Alaska Department of Environmental Conservation

June 21, 2010

prepared by:

Sierra Research, Inc.
1801 J Street
Sacramento, California 95811
(916) 444-6666

Report No.SR2010-06-01

2010 FAIRBANKS HOME HEATING SURVEY

prepared for:

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June 21, 2010

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2010 FAIRBANKS HOME HEATING SURVEY

Table of Contents

List of Figures

List of Tables

1. SUMMARY

Under Contract No. 18-5022-10 funded by the Alaska Department of Environmental Conservation (ADEC), Sierra Research, Inc. (Sierra) conducted a telephone-based survey of residential home heating devices and practices within the Fairbanks $PM_{2.5}$ nonattainment area. Sierra coordinated the study and performed validation and analysis of the collected data. Sierra hired Hays Research Group (Hays) to randomly sample households by ZIP code within the nonattainment area, perform the telephone survey, and deliver the detailed, electronically recorded survey data results to Sierra. The telephone survey was conducted between January 22 and February 16, 2010. A total of 300 household responses were targeted. After review of the recorded data, a validated sample of 299 households remained.

Purpose – The primary purpose of this study was to collect up-to-date information on residential heating practices in Fairbanks during the winter season when extremely cold ambient temperatures cause a significant seasonal increase in fuel combustion for residential heating. Sierra and Hays had conducted similar ADEC-sponsored telephone-based home heating surveys in Fairbanks during the 2005-2006 and 2006-2007 winter seasons. The results of those earlier studies suggested that wood burning use had increased measurably since earlier in the decade, which was likely caused by the large run-up in home heating oil prices during that timeframe.[*]

ADEC funded this latest survey to ascertain whether this trend or level of wood use has continued and to gain information about other heating types and fuels, such as outdoor wood boilers and coal, that were not explicitly identified in the earlier 2006 and 2007 surveys for use in preparing updated emission inventories to support development of the $PM_{2.5}$ State Implementation Plan for Fairbanks.

Survey Content – The survey focused on identifying the types and usage practices of different home heating devices used in residences within the nonattainment area during winter months. It was organized into a hierarchical series of 71 separate questions that respondents were asked to answer based on the types of heating devices available and used within their homes. Key questions included listing the types of devices used in the household (including the specific type of wood-burning device if used), identifying whether multiple devices were used in the household, and estimating the amount of fuel used in each device (e.g., cords of wood or gallons of heating oil) both during winter and on an annual basis.

[*] Given the energy needed to heat homes in Fairbanks under extremely cold wintertime temperatures, home heating costs are substantial. Wood-burning devices offer a cheaper alternative to heating oil at current market prices.

The survey also included questions about future home heating practices, such as estimating the heating oil price that would trigger each respondent to stop burning wood and indicating whether respondents planned to change the devices currently being used for home heat some time within the next two years.

For the first time, the survey also asked respondents to estimate the moisture content of their wood and drying or seasoning periods (in months) before wood is burned. As described later in the report, the results of the moisture content estimates are of questionable value because of the small number of responses to that question and the difficultly for most residents to accurately estimate the moisture levels in their wood. (As discussed later in the report, a separate, concurrent study to this effort is being conducted to collect actual wood moisture measurements.)

Study Phases and Issues Encountered – The study consisted of three primary phases as listed and summarized below.

1. *Design* – The design phase included two key elements. First, a methodology based on U.S. Census data was applied to determine how many households to sample within each of the ZIP codes contained in the nonattainment area to produce a representative cross-section of heating practices that vary within the area (for example, to account for the fact that only portions of the area have access to steam-circulated District or "municipal" heat). Second, the survey structure and questionnaire used in the earlier home heating surveys were re-designed to incorporate several additional questions (e.g., wood moisture content) and ensure these additional questions were asked at logical points during the survey. Sierra and Hays collaborated on this phase.

2. *Survey* – The second phase of the study consisted of performing the actual telephone survey and recording the individual household responses to each question into a series of well-organized electronic data files. Hays performed this phase.

3. *Analysis* – The third and final phase of the effort consisted of first performing a detailed set of data consistency and range checks on the survey response data collected and electronically recorded by Hays, and then analyzing and tabulating the results. Sierra performed this phase.

Two key issues arose during the course of the effort that deserve mention.

First, when performing the field consistency and validation checks on the response data, roughly 100 data records either had inconsistencies between interrelated data responses or were outside reasonable limits. Sierra prepared a detailed list of each of these errors/inconsistencies and transmitted it to Hays. After collective review, it was agreed that most of these errors/inconsistencies could be fairly easily corrected by simply editing specific fields in the response database. For example, in the initial section of the survey where the types of heating devices available in each household are recorded, a wood-burning device may have been recorded with a "No" value, even though subsequent sections of the survey reflected use of a wood-burning device Hays confirmed that cases like these were clear instances where the response in the initial section was incorrect (as corroborated by the types of data subsequently recorded for that household). In this example, the response in the initial section was simply changed from “No” to “Yes.”

These types of corrective edits were made only when it was clear what should have been entered into the response database. For those 12 records where the intended responses could not be clearly inferred and corrections could thus not be made, Hays re-sampled “replacement” households.

Second, under the analysis phase of the effort Sierra also planned to perform a series of comparisons of key device counts and usage rates between the 2006, 2007, and 2010 survey data to look for trends and examine usage variations in the samples. While integrating the similarly validated data from the 2006 and 2007 surveys, it was recalled that the ZIP-code-specific sampling targets (and households sampled) in the 2006 and 2007 survey were developed using a different approach to that taken for the 2010 survey. To ensure proper comparisons across the survey samples, the ZIP-code tabulated results from these earlier surveys were re-weighted to composite totals using the same weightings from the 2010 survey. This was not a trivial effort, but was necessary to ensure the comparisons across survey samples were not biased by differing sampling strategies and thus potentially misleading.

Key Findings - Key results from the 2010 survey included tabulated estimates of the number and types of heating devices used within the PM2.5 nonattainment area, as well as per household usage rates for each type of device based on the survey responses.

Device Counts - First, Table 1-1 summarizes the counts of devices found in the survey sample along with estimates of total heating devices within the entire Fairbanks $PM_{2.5}$ nonattainment area. The device types are identified by both a short code and descriptive name as well as indentation in the leftmost column of Table 1-1 to clarify the separate sub-categories reported within the wood-burning sector. As shown in the highlighted “Nonattainment Area” column, woodstoves and central oil furnaces are the most common heating devices, with estimated counts of 7,980 and 21,130, respectively, over the entire nonattainment area. Of the combined total of 8,610 free-standing woodstoves and fireplaces with inserts, roughly one-third (2,930) are un-certified (pre-1988) models. In addition, almost all of the woodstoves and fireplaces with inserts burn cord wood (8,520). Only 370 were estimated to burn wood pellets based on the limited number of pellet-burning respondents (four) in the survey.

Fireplaces without inserts, estimated at a relatively small population of 540 according to Table 1-1, may nevertheless be significant contributors to the emission inventory from wood-burning devices. This is due to the fact that their heating efficiency is much less than those equipped with inserts or woodstoves.

The estimates of appliance counts are subject to statistical uncertainty as in any survey. The uncertainty in the estimate depends on the total sample size and the counts observed by appliance type in the category, being relatively larger for the categories with a small number of devices.

Table 1-1 2010 Survey Sampled Heating Devices Counts and Estimated Counts within the Fairbanks $PM_{2.5}$ Nonattainment Area				
	Number of Devices			
Heating Device Type	Survey Sample	**Nonattainment Area**	Standard Error	Probable Range
1 - Wood-Burning Device	108[a]	**9,240**	±810	8,400 - 10,000
1a - Fireplace without insert	6 [a]	**540**	±210	330 - 750
1b - Fireplace with insert	7 [a]	**630**	±230	400 - 860
1c - Woodstove	89 [a]	**7,980**	±740	7,200 - 8,700
All Inserts & Woodstoves (1b+1c)	96 [a]	**8,610**	±770	7,800 - 9,400
Stove/Insert, Uncertified	31 [a]	**2,930**	±480	2,500 - 3,400
Stove/Insert, Certified	60 [a]	**5,680**	±650	5,000 - 6,300
Stove/Insert Using Cord Wood	90 [a]	**8,250**	±750	7,500 - 9,000
Stove/Insert Using Pellets	4 [a]	**370**	±180	190 - 540
1d - Outdoor Wood Boiler	1 [a]	**90**	±90	0 - 180
2 - Central Oil Furnace	247	**21,130**	±920	20,200 - 22,100
3 - Portable Heater	11	**940**	±280	660 - 1,220
4 - Direct Vent Heater	53	**4,530**	±590	3,900 - 5,100
5 - Natural Gas Heating	16	**1,370**	±340	1,000 - 1,700
6 - Coal Heat	4	**340**	±170	170 - 510
7 - District Heat	7	**600**	±220	370 - 820
8 - Other	22	**1,880**	±390	1,500 - 2,300
All Heating Devices	**468**	**40,040**	**±1,510**	**38,500 - 41,600**

[a] Survey sample counts within the wood-burning sector do not match total due to "unknown" responses.

For example, smaller size count estimates shown in Table 1-1 for devices such as outdoor wood boilers and coal heating devices, are likely to reflect a higher degree of uncertainty because of the fact that very limited amounts of these devices were found in the 299-household survey sample.

The two rightmost columns in Table 1-1 show these computed statistical uncertainties reflected in the device count estimates for the entire nonattainment area. The uncertainties are quantified using the statistical formula for the standard error of a proportion,[*] based on the total sample size of 468 appliances and the estimated appliance count expressed as a percent of the total. For example, there are 247 oil furnaces in the survey or 52.8% of the total. The standard error of estimate for this proportion is ±2.3% in a survey of 468 appliances, meaning that the actual percentage of oil furnaces will fall

[*] See, for example, Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, Milton, J.S., J.C. Arnold – Third Edition. Irwin McGraw-Hill. Boston, MA. 1995. pp 321-323.

within the range from 50.5% to 55.1% with 68 percent probability (the probability under the normal distribution curve between +1 and -1 standard deviations from the mean). The uncertainty in the proportion of oil furnaces translates into an uncertainty of ±920 units in the estimated population of 21,130 oil furnaces. The probable range is the number of oil furnaces likely to exist within the non-attainment area with 68 percent probability. There will be only about 1 chance in 3 that the actual number will fall outside this range – being either less than 20,200 or more than 22,100. The statistical uncertainties were estimated in this manner at the most detailed response level of the survey and then aggregated up to estimate uncertainties in category totals and for the entire appliance population in the non-attainment area.

To simplify interpretation of the table, the estimated numbers of appliances in the non-attainment area and the associated standard errors have been rounded to the nearest 10 units, and the probable range for the number of appliances of each type has been rounded to the nearest 10 or 100 units depending on the size of the category.

(As indicated with a footnote in Table 1-1, individual device counts from the survey sample for individual types of wood-burning devices do not sum to the total number of reported wood-burning devices from the survey. This is due to the fact in some instances, although respondents indicated the household had a wood-burning device, they were unsure which type it was or what its certification status was. Section 4 of the report explains how these unknown sub-types were handled.)

(Section 4 of the report includes a more detailed discussion of the statistical uncertainty reflected in the 2010 survey data.)

As explained in greater detail later in the report, the device count estimates in Table 1-1 were developed by extrapolating the number of devices recorded in the 299-household survey sample to the entire nonattainment area based on household counts by ZIP code from the 2000 U.S. Census.

Table 1-2 summarizes the difference between the total number of households in the nonattainment area and the number of sampled households by ZIP code. The ratio of total-to-sampled households is shown in the bottom row of Table 1-2. This extrapolation factor was used to expand the number of home heating devices counted in the survey sample to the estimates for the entire nonattainment area presented earlier in Table 1-1.

Table 1-2
Comparison of Total Households and Survey-Sampled Households by ZIP Code

Parameter	Downtown 99701	Wainwright[a] 99703	North Pole 99705	Airport 99709	Steese 99712	University 99775	**All**
Total Households	7,164	1,822	5,329	8,774	2,389	105	25,583
Sampled Households	86	21	61	102	28	1	299
Extrapolation Factor	*83.30*	*86.76*	*87.36*	*86.02*	*85.32*	*105.00*	*85.56*

The differences between the number of households in the survey sample and entire nonattainment area listed in Table 1-2 need to be kept in mind when interpreting average household fuel usage rates and heating costs by device type, which are presented in the following two tables.

Fuel Usage and Heating Costs by Equipped Household – Table 1-3 summarizes average fuel use rates (the amount of fuel per season or year) and heating costs by device type for households equipped with or using each device/fuel from the survey sample. As reflected in both the individual ZIP codes and the entire sample (shown in the rightmost column labeled "All"), winter[*] heating device usage rates or costs were an overwhelming portion of annual totals. This is not surprising given the strong seasonal variations in ambient temperature and resultant heating demand experienced in Fairbanks.

Table 1-3
Wood Burning, Heating Oil and Other Fuel Usage Rates and Heating Costs per Equipped Household from the 2010 Survey

Device Type & Fuel	Usage Period	Dntown 99701	Wnwrght[a] 99703	Nth Pole 99705	Airport 99709	Steese 99712	Univ 99775	**All**
Stove/Insert Wood Use (cords)	Annual	3.50	3.50	5.23	3.54	3.30	n/a	3.95
	Winter	3.10	3.25	4.71	3.28	2.70	n/a	3.60
Fireplace Wood Use (cords)	Annual	n/a	n/a	6.00	4.00	n/a	n/a	5.20
	Winter	n/a	n/a	5.67	3.00	n/a	n/a	4.60
Central Oil Use (gal)	Annual	1,258	1,083	996	1,141	1,053	n/a	1,135
	Winter	805	875	749	883	781	n/a	818
Portable Heater Fuel Use (gal)	Annual	n/a	n/a	20	2	300	n/a	107
	Winter	n/a	n/a	20	2	300	n/a	107
Direct Vent Heater Fuel Use (gal)	Annual	700	n/a	733	403	417	n/a	493
	Winter	625	n/a	633	311	417	n/a	444
Natural Gas Fuel Cost (dollars)	Annual	$1,950	$900	n/a	$2,717	n/a	No data	$2,159
	Winter	$1,700	$700	n/a	$1,180	n/a	No data	$1,260
District Heat Fuel Cost (dollars)	Annual	$2,800	$2,000	n/a	n/a	n/a	n/a	$2,400
	Winter	$1,500	$1,200	n/a	n/a	n/a	n/a	$1,350

[a] Also includes Birch Hill area
n/a – Not applicable (i.e., indicates where a device was not found in the sample for a specific ZIP code)

As shown in Table 1-3, fuel usage estimates were available for most of the surveyed heating devices: wood-burning devices, central oil furnaces, and portable and direct-vent heaters. Winter fuel usage for the two most common heating devices—central oil furnaces and woodstoves—was 818 gallons of heating oil and 3.60 cords of wood, respectively.

[*] In the 2010 survey, winter usage was defined as that from October through March.

For those heating devices such as natural gas or District heating where the amount of fuel is less well known, the survey respondents were asked to provide usage estimates in the form of heating costs for each device. The seasonal and annual natural gas and District heating costs presented in Table 1-3 represent averages of respondent estimates across those households where each device was used.

Wood-Burning Usage Patterns – On average, Table 1-3 indicates that those households equipped with woodstoves or fireplaces with inserts burned 3.60 cords of wood during the October through March winter months and 3.95 cords annually. Households using fireplaces without inserts (referred to in Table 1-3 and subsequent tables as simply "fireplaces") exhibited greater average wood use: 4.60 cords during winter and 5.20 cords over the entire year. Though not shown in Table 1-3, the single household identified in the survey using an outdoor wood boiler indicated that they burned a total of six cords, all during winter.

The higher wood usage for fireplaces without inserts seen in Table 1-3 is consistent with the point raised earlier that they have much lower effective heating efficiency than fireplaces equipped with inserts or woodstoves. More wood must be burned in these "no-insert" fireplaces to deliver the same amount of effective heat. As it relates to their contribution to emissions inventory, a key question is how are fireplaces without inserts used, as primary or significant heating sources, or more for ambiance/aesthetics and less for heating?

In the 2010 survey sample, a total of six households were found that had no-insert fireplaces as a home heating device. Of these six households, all but one (83%) indicated that they used their fireplaces as a heating source during winter at least 40% of the time. In one household, the no-insert fireplace was the sole heating device; the respondent indicated that a total of eight cords of wood was burned during winter. In addition, all of these six respondents indicated they either cut their own wood, or both buy and cut their wood. This suggests that at least in these households, wood costs may be less of a factor than in other wood-burning households.

Though this is a very limited sample, usage practices of fireplaces without inserts from the 2010 survey suggest they were not simply used as minor heating source or simply for ambiance, but burned large amounts of wood and were used as major, if not primary, household heating sources. By comparison, homes equipped with fireplace inserts or woodstoves used these devices 31% and 50% of the time during winter, respectively, based on respondent estimates from the 2010 survey.

A quick review of households containing fireplaces without inserts from the 2006 and 2007 survey data was performed to see if similar practices were observed in those previous samples. In both of these samples, a different pattern was seen. These samples contained 16 and 20 households, respectively, with "no-insert" fireplaces. In each sample, only a single household was identified as using its fireplace as a significant heating source (defined as 40% of more) during winter. Thus, the fraction of no-insert fireplaces used as a significant heating source based on these survey samples was 5-6%, much less than found in the 2010 survey. Not coincidentally, wood use in these two households was significant: 3-4 cords during winter. In the remaining "occasional fireplace use" households from the 2006 and 2007 survey, average household winter wood use was roughly one cord.

This disparity between usage patterns of no-insert fireplace households between the 2010 and earlier survey samples indicates that individual no-insert households exhibit significant wood-burning emissions, although extrapolating these disparate usage patterns to all no-insert households in the nonattainment area reflects a high degree of uncertainty. Usage practices in no-insert households clearly need to be better understood.

(Two cells Table 1-3 are listed as "No data." For the one household sampled in this ZIP code, the respondent did not provide natural gas heating cost estimates.)

Fuel Usage and Heating Costs by Any Household – The seasonal and annual usages and heating costs presented earlier in Table 1-3 are not to be confused with averages across all households in the sample, whether or not a household had or used a specific type of heating device. Averages across all households (i.e., any household), which provide a better basis for calculating emission inventories, are displayed in Table 1-4.

Table 1-4
Wood Burning, Heating Oil and Other Fuel Usage Rates and Heating Costs per Household (Any Household) from the 2010 Survey

Device Type & Fuel	Usage Period	Dntown 99701	Wnwrght[a] 99703	Nth Pole 99705	Airport 99709	Steese 99712	Univ 99775	**All**
Stove/Insert Wood Use (cords)	Annual	0.53	0.83	2.23	1.42	1.30	n/a	**1.27**
	Winter	0.47	0.77	2.01	1.32	1.06	n/a	**1.15**
Fireplace Wood Use (cords)	Annual	n/a	n/a	0.30	0.12	n/a	n/a	**0.10**
	Winter	n/a	n/a	0.28	0.09	n/a	n/a	**0.09**
Central Oil Use (gal)	Annual	1,141	619	833	906	940	n/a	**938**
	Winter	730	500	626	701	697	n/a	**676**
Portable Heater Fuel Use (gal)	Annual	n/a	n/a	0.98	0.08	10.71	n/a	**3.95**
	Winter	n/a	n/a	0.98	0.08	10.71	n/a	**3.95**
Direct Vent Heater Fuel Use (gal)	Annual	90	n/a	84	87	104	n/a	**87**
	Winter	80	n/a	73	67	104	n/a	**79**
Natural Gas Fuel Cost (dollars)	Annual	$113	$171	n/a	$133	n/a	No data	**$116**
	Winter	$99	$133	n/a	$58	n/a	No data	**$67**
District Heat Fuel Cost (dollars)	Annual	$65	$381	n/a	n/a	n/a	n/a	**$56**
	Winter	$35	$229	n/a	n/a	n/a	n/a	**$32**

[a] Also includes Birch Hill area
n/a – Not applicable (i.e., indicates where a device was not found in the sample for a specific ZIP code)

Average device usage rates and heating costs on this any-household basis in Table 1-4 are by definition, lower than corresponding values presented earlier in Table 1-3. This is because the denominator or number of households being averaged in Table 1-4 is always larger, and in many cases significantly larger, than the number of equipped households on which the Table 1-3 averages are based.

The difference between the two sets of averages in Tables 1-3 and 1-4 are perhaps best explained by example. According to Table 1-3, average winter wood use in households equipped with woodstoves or fireplaces with inserts was 3.60 cords. This average represents only those households within the survey with these wood-burning devices. As reported earlier in Table 1-1, the total number of woodstove or fireplace-with-insert households in the survey sample was 96 (7 + 89). The total amount of wood burned across these households is 345.6 cords (96 equipped households × 3.60 cords/household). The total number of households in the survey sample, irrespective of which heating devices they used, was 299. Thus, the average winter woodstove/insert use across all (or any) households in the survey sample is 1.15 cords (345.6 total cords ÷ 299 total households) as reported in Table 1-4.

Although less intuitive, this same averaging approach was applied to the heating cost estimates for natural gas and District heating shown at the bottom of Table 1-4. In these cases, the averages across all households in the survey are much lower than the equipped household averages given in Table 1-3 because these heating devices were less common.

Comparisons Across Surveys – Finally, Table 1-5 presents a comparison of key tabulations from each of the three separate Fairbanks Home Heating surveys: 2006, 2007, and the current 2010 survey. As explained earlier, the tabulations from the earlier surveys were re-weighted by ZIP code using the same weightings on which the 2010 survey was based for consistency when compared with the 2010 results. Highlighted cells in Table 1-5 identify key metrics where significant changes were observed in the 2010 survey compared to the earlier surveys.

First, the overall percentage of wintertime wood-burning device use increased to over 17% in the 2010 sample (over usage fractions of 10-12% in the earlier surveys). In addition, the distribution of wood-burning devices used has changed: no-insert fireplace use is lower in the 2010 sample (5.8%), while woodstove use is higher (86.4%). Within the populations of woodstoves and fireplaces with inserts in the survey samples, the fraction of un-certified stoves/inserts has dropped markedly from 52.4% in 2006 to 34.1% in 2010. On the other hand, winter wood usage (i.e., the amount burned per wood-burning household) has increased noticeably for both stoves/inserts and no-insert fireplaces. (As discussed earlier, the variations observed for the no-insert fireplaces may be related to small sample sizes.)

Beyond the wood-burning sector, Table 1-5 also highlights a clear reduction in the wintertime central oil use. Although the usage fraction for central oil furnaces (the respondent-estimated fraction of use within the household) had remained fairly steady, between 63.9% and 68.0% as reported in the upper section of Table 1-5, usage amounts (gallons of fuel oil) per household dropped nearly 20% in the 2010 sample (818 gallons) compared to the earlier surveys.

Table 1-5 Summary of Key Results from 2006, 2007 and 2010 Home Heating Surveys				
Statistic	Parameter	Survey Results		
		2006[a]	2007[a]	2010
Average Winter Device Use by Type (% of Household Use)	Wood	**10.1%**	**11.8%**	**17.2%**
	Central Oil	68.0%	63.6%	67.3%
	Portable	0.7%	0.5%	0.2%
	Direct Vent	8.6%	7.4%	8.2%
	Natural Gas	2.6%	2.3%	4.5%
	Coal Heat	n/a	n/a	0.5%
	District Heat	2.8%	1.1%	1.3%
	Other	7.2%	13.4%	0.7%
Wood Burning Type (% of Wood-Burning Devices)	Fireplace	**13.0%**	**17.5%**	**5.8%**
	Fireplace + Insert	8.3%	5.6%	6.8%
	Woodstove	**78.8%**	**76.9%**	**86.4%**
	Wood Boiler	n/a	n/a	1.0%
Wood Stove/Insert Cert Type (% of Woodstoves/Inserts)	<1988 (Un-Certified)	**52.4%**	**46.8%**	**34.1%**
	≥1988 (Certified)	**47.6%**	**53.2%**	**65.9%**
Stove/Insert Wood Use (cords), Winter	Winter Season	**2.87**	**2.85**	**3.60**
Fireplace Wood Use (cords), Winter	Winter Season	**0.76**	**0.74**	**4.60**
Central Oil Use (gallons), Winter	Winter Season	**1,099**	**1,011**	**818**
Portable Heater Fuel Use (gallons), Winter	Winter Season	91.7	152.7	107.3
Direct Vent Heater Fuel Use (gallons), Winter	Winter Season	296	472	444
Natural Gas Heating Fuel Cost (dollars), Winter	Winter Season	**$553**	**$947**	**$1,260**
Municipal Heating Fuel Cost (dollars), Winter	Winter Season	n/a	n/a	$1,350

[a] Winter usage in these surveys encompassed October-May; 2010 winter usage spanned October-March.

To understand the possible causes of this decrease in central oil usage, an analysis of wintertime Fairbanks heating degree days* was conducted. Comparisons of degree days during the same six-month winter periods of each survey indicated that ambient temperature-based heating demand in 2010 was roughly 94% of the winter average of 2006 and 2007. Therefore, most of the 20% decrease in central oil usage seen in the 2010 survey was not the result of year-to-year ambient temperature variations. The other likely explanations for this decrease are either: 1) participation in the recently-initiated Alaska Home Energy Rebate Program†; or 2) a shift to other devices/fuels resulting from market prices of heating oil. (An analysis of the effects of participation in the Home Energy Rebate Program was beyond the scope of this study.)

* Calculated 65°F heating degree days at Fairbanks International Airport (PAFA), www.degreedays.net

† Alaska Housing Finance Corporation, http://www.akrebate.com/rebate_about.aspx

A significant increase in wintertime natural gas heating costs per equipped household is also highlighted in Table 1-5. Costs per household have more than doubled from $553 in 2006 to $1,260 in 2010. Whether this reflects a greater usage of natural gas heating is unclear; no analysis of changes in residential natural gas heating prices over this four-year period was performed. However, as also reported in Table 1-5, respondent-estimated usage fraction for natural gas heating increased from 2.6% in 2006 to 4.5% in 2010.

As footnoted in Table 1-5, one element that was not fully consistent across the three surveys was the definition of winter season activity. For the 2006 and 2007 surveys, winter was defined as October through May; as noted earlier, the 2010 survey defined winter as October through March. Rather than try to adjust[*] the results data from the earlier surveys downward to reflect the shorter winter period in the 2010 survey, this difference is simply noted. Thus, the higher winter season usage seen in the 2010 survey would be further magnified if a seasonal adjustment were made.

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[*] Given the strong relationship between ambient temperature and residential heating demand/activity, it is not appropriate to simply adjust the 2006 and 2007 usage data by the difference in winter periods across the three surveys (i.e., by a factor of 6/8 months.) because historical April-May ambient temperatures tend to be much warmer than the average from October-March.

2. INTRODUCTION

This introduction provides a review of the background behind the effort, the project objectives, and the organization of the remainder of the report.

2.1 Background

Fairbanks has been collecting measurements of fine particulate ($PM_{2.5}$) concentrations at the State Office Building in the downtown area for over a decade. Those measurements show a distinct seasonal pattern of elevated concentrations during both summer and winter months. Large, uncontrolled wild fires are the principal cause of the elevated summer values. The causes of the elevated winter values are more complex and include severe meteorology (i.e., low wind speed, low mixing depth heights, and arctic winter temperatures) that limit dispersion potential, combustion of fuel for space heating and power production as well as poorly understood atmospheric chemistry that promotes secondary particulate formation. Collectively, these factors have caused the Borough to routinely exceed the more stringent 35 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ that the U.S. Environmental Protection Agency (EPA) established in 2006, and resulted in Fairbanks being designated as a $PM_{2.5}$ nonattainment area in December 2009.

ADEC has sponsored this study to collect information on the types and usage rates of residential heating equipment and fuels in Fairbanks. The specific heating devices/fuels that were surveyed are listed below.

- Wood-burning devices (fireplaces, fireplaces with inserts and woodstoves)
- Central oil furnaces
- Portable fuel oil/kerosene devices
- Direct-vent type heaters such as Toyo or Monitor brands
- Natural gas heating
- Coal heating
- District* heating (from circulated steam)

The study method was a telephone-based survey conducted by Hays Research Group (Hays) over a sample of roughly 300 residential households in Fairbanks. The survey

* The household survey form and electronic response database use the term "Municipal Heating" to refer to district heating provided within portions of the Fairbanks area from steam circulated in underground pipes. For this point in the report forward, district and municipal heating refer to this same type of steam heating.

APPENDIX C

2010 Fairbanks Home Heating Survey Normalized Tabulations

TABULATIONS OF FAIRBANKS 2010 HOME HEATING SURVEY									
			99701	99703	99705	99709	99712	99775	All
Parameter	Stat	Type	Downtown	Wainwright	North Pole	Airport	Steese	University	All
Survey Sample	# Obs		86	21	61	102	28	1	299
(Self-weighted by ZIP households)	% Obs		**28.8%**	**7.0%**	**20.4%**	**34.1%**	**9.4%**	**0.3%**	**100.0%**
Multiple Type Heating	UseFactor	(1.0=Single)	**1.40**	**1.62**	**1.59**	**1.68**	**1.61**	**1.00**	**1.57**
Average Use by Type, Winter (October-March)	**% Obs**	**Wood**	**6.8%**	**9.8%**	**28.6%**	**20.1%**	**19.5%**	**0.0%**	**17.2%**
	% Obs	**Central Oil**	**80.8%**	**44.3%**	**63.2%**	**63.2%**	**69.6%**	**0.0%**	**67.3%**
	% Obs	**Portable**	**0.1%**	**2.4%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.2%**
	% Obs	**Direct Vent**	**7.0%**	**17.4%**	**3.5%**	**9.7%**	**10.5%**	**0.0%**	**8.2%**
	% Obs	**Natural Gas**	**4.7%**	**14.3%**	**1.6%**	**4.4%**	**0.0%**	**100.0%**	**4.5%**
	% Obs	**Coal Heat**	**0.0%**	**0.0%**	**0.1%**	**1.5%**	**0.0%**	**0.0%**	**0.5%**
	% Obs	**Muni. Heat**	**0.6%**	**11.7%**	**1.6%**	**0.0%**	**0.0%**	**0.0%**	**1.3%**
	% Obs	**Other**	**0.1%**	**0.2%**	**1.2%**	**1.1%**	**0.4%**	**0.0%**	**0.7%**
		All	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Wood Burning Type (Q1a)	# Obs	Fireplace	0	0	3	3	0	0	6
	# Obs	FP+Insert	1	1	1	3	1	0	7
	# Obs	Stove	12	4	25	38	10	0	89
	# Obs	Wood Boiler	0	0	0	1	0	0	1
	# Obs	Unknown	0	0	0	1	0	0	1
	# Obs	N/A	73	16	32	56	17	1	195
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	13	5	29	45	11	0	103
	% Obs	**Fireplace**	**0.0%**	**0.0%**	**10.3%**	**6.7%**	**0.0%**	**0.0%**	**5.8%**
	% Obs	**FP+Insert**	**7.7%**	**20.0%**	**3.4%**	**6.7%**	**9.1%**	**0.0%**	**6.8%**
	% Obs	**Stove**	**92.3%**	**80.0%**	**86.2%**	**84.4%**	**90.9%**	**0.0%**	**86.4%**
	% Obs	**Wood Boiler**	**0.0%**	**0.0%**	**0.0%**	**2.2%**	**0.0%**	**0.0%**	**1%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Wood Stove/Insert Installation Year / Cert Type (Q10a)	# Obs	<1988 (Un-Certified)	2	3	12	13	1	0	31
	# Obs	>=1988 (Certified)	10	2	14	25	9	0	60
	# Obs	Unknown	1	0	0	3	1	0	5
	# Obs	N/A	73	16	35	61	17	1	203
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	12	5	26	38	10	0	91
	% Obs	**<1988 (Un-Certified)**	**16.7%**	**60.0%**	**46.2%**	**34.2%**	**10.0%**	**0.0%**	**34.1%**
	% Obs	**>=1988 (Certified)**	**83.3%**	**40.0%**	**53.8%**	**65.8%**	**90.0%**	**0.0%**	**65.9%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Wood Stove/Insert Fuel Type (Q12)	# Obs	Pellets	1	0	0	2	1	0	4
	# Obs	Cord Wood	11	5	26	38	10	0	90
	# Obs	Unknown	1	0	0	1	0	0	2
	# Obs	N/A	73	16	35	61	17	1	203
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	12	5	26	40	11	0	94
	% Obs	**Pellets**	**8.3%**	**0.0%**	**0.0%**	**5.0%**	**9.1%**	**0.0%**	**4.3%**
	% Obs	**Cord Wood**	**91.7%**	**100.0%**	**100.0%**	**95.0%**	**90.9%**	**0.0%**	**95.7%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Wood Stove/Insert Daily Use Profile, Winter (Q13)	# Obs	Daytime	0	1	0	4	0	0	5
	# Obs	Evening	0	1	2	3	0	0	6
	# Obs	Day&Eve	4	1	16	20	7	0	48
	# Obs	Weekend	1	0	0	0	0	0	1
	# Obs	Eve&WkEnd	2	2	4	6	1	0	15
	# Obs	Occasional	1	0	3	5	2	0	11
	# Obs	Not Using	2	0	0	0	0	0	2
	# Obs	Unknown	0	0	1	0	0	0	1
	# Obs	N/A	1	0	0	0	0	0	1
	# Obs	All	75	16	35	64	18	1	209
	# Obs	All With	10	5	25	38	10	0	88
	% Obs	**Daytime**	**0.0%**	**20.0%**	**0.0%**	**10.5%**	**0.0%**	**0.0%**	**5.7%**
	% Obs	**Evening**	**0.0%**	**20.0%**	**8.0%**	**7.9%**	**0.0%**	**0.0%**	**6.8%**
	% Obs	**Day&Eve**	**40.0%**	**20.0%**	**64.0%**	**52.6%**	**70.0%**	**0.0%**	**54.5%**
	% Obs	**Weekend**	**10.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.1%**
	% Obs	**Eve&WkEnd**	**20.0%**	**40.0%**	**16.0%**	**15.8%**	**10.0%**	**0.0%**	**17.0%**
	% Obs	**Occasional**	**10.0%**	**0.0%**	**12.0%**	**13.2%**	**20.0%**	**0.0%**	**12.5%**
	% Obs	**Not Using**	**20.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**2.3%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Wood Stove/Insert Wood Source (Q14)	# Obs	Cut Own-multi response	5	2	6	4	0	0	17
	# Obs	Buy	6	2	9	17	0	0	34
	# Obs	Cut Own	5	3	17	21	10	0	56
	# Obs	Unknown	75	16	35	64	18	1	209
	# Obs	N/A	86	21	61	102	28	1	299
	# Obs	All	0	0	0	0	0	0	0
	# Obs	All With	11	5	26	38	10	0	90
	% Obs	**Buy**	**54.5%**	**40.0%**	**34.6%**	**44.7%**	**0.0%**	**0.0%**	**37.8%**
	% Obs	**Cut Own**	**90.9%**	**100.0%**	**88.5%**	**65.8%**	**100.0%**	**0.0%**	**81.1%**
	% Obs	**All With**	**145.5%**	**140.0%**	**123.1%**	**110.5%**	**100.0%**	**0.0%**	**118.9%**
Wood Stove/Insert Cutting Permit Obtained (Q15)	# Obs	Yes	5	2	11	8	4	0	30
	# Obs	No	5	3	12	16	6	0	42
	# Obs	Unknown	0	0	0	1	0	0	1
	# Obs	N/A	76	16	38	77	18	1	226
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	10	5	23	24	10	0	72
	% Obs	**Yes**	**50.0%**	**40.0%**	**47.8%**	**33.3%**	**40.0%**	**0.0%**	**41.7%**
	% Obs	**No**	**50.0%**	**60.0%**	**52.2%**	**66.7%**	**60.0%**	**0.0%**	**58.3%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**

TABULATIONS OF FAIRBANKS 2010 HOME HEATING SURVEY

Parameter	Stat	Type	99701 Downtown	99703 Wainwright	99705 North Pole	99709 Airport	99712 Steese	99775 University	All All
Wood Fireplace Daily Use Profile, Winter (Q24)	# Obs	Daytime							
	# Obs	Evening							
	# Obs	Day&Eve	0	0	3	1	0	0	4
	# Obs	Weekend							
	# Obs	Eve&WkEnd	0	0	0	2	0	0	2
	# Obs	Occasional							
	# Obs	Not Using							
	# Obs	Unknown							
	# Obs	N/A	86	21	58	99	28	1	293
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	0	0	3	3	0	0	6
	% Obs	**Daytime**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	% Obs	**Evening**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	% Obs	**Day&Eve**	**0.0%**	**0.0%**	**100.0%**	**33.3%**	**0.0%**	**0.0%**	**66.7%**
	% Obs	**Weekend**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	% Obs	**Eve&WkEnd**	**0.0%**	**0.0%**	**0.0%**	**66.7%**	**0.0%**	**0.0%**	**33.3%**
	% Obs	**Occasional**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	% Obs	**Not Using**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	% Obs	**All With**	**0.0%**	**0.0%**	**100.0%**	**100.0%**	**0.0%**	**0.0%**	**100.0%**
Wood Fireplace Wood Source (Q25)	# Obs	Buy	0	0	1	1	0	0	2
	# Obs	Cut Own	0	0	2	1	0	0	3
	# Obs	Unknown	0	0	0	1	0	0	1
	# Obs	N/A	86	21	58	99	28	1	293
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	0	0	3	2	0	0	5
	% Obs	**Buy**	**0.0%**	**0.0%**	**33.3%**	**50.0%**	**0.0%**	**0.0%**	**40.0%**
	% Obs	**Cut Own**	**0.0%**	**0.0%**	**66.7%**	**50.0%**	**0.0%**	**0.0%**	**60.0%**
	% Obs	**All With**	**0.0%**	**0.0%**	**100.0%**	**100.0%**	**0.0%**	**0.0%**	**100.0%**
Wood Fireplace Cutting Permit Obtained (Q26)	# Obs	Yes	0	0	1	2	0	0	3
	# Obs	No	0	0	2	0	0	0	2
	# Obs	Unknown							
	# Obs	N/A	86	21	58	100	28	1	294
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	0	0	3	2	0	0	5
	% Obs	**Yes**	**0.0%**	**0.0%**	**33.3%**	**100.0%**	**0.0%**	**0.0%**	**60.0%**
	% Obs	**No**	**0.0%**	**0.0%**	**66.7%**	**0.0%**	**0.0%**	**0.0%**	**40.0%**
	% Obs	**All With**	**0.0%**	**0.0%**	**100.0%**	**100.0%**	**0.0%**	**0.0%**	**100.0%**
Stove/Insert Wood Use (cords), Annual (Q18)	**Average**	**Per Equipped Household**	**3.50**	**3.50**	**5.23**	**3.54**	**3.30**	**#DIV/0!**	**3.95**
Stove/Insert Wood Use (cords), Winter (Q19)	**Average**	**Per Equipped Household**	**3.10**	**3.25**	**4.71**	**3.28**	**2.70**	**#DIV/0!**	**3.60**
Fireplace Wood Use (cords), Annual (Q29)	**Average**	**Per Equipped Household**	**#DIV/0!**	**#DIV/0!**	**6.00**	**4.00**	**#DIV/0!**	**#DIV/0!**	**5.20**
Fireplace Wood Use (cords), Winter (Q30)	**Average**	**Per Equipped Household**	**#DIV/0!**	**#DIV/0!**	**5.67**	**3.00**	**#DIV/0!**	**#DIV/0!**	**4.60**
Central Oil Use (gallons), Annual (Q42)	**Average**	**Per Equipped Household**	**1,258**	**1,083**	**996**	**1,141**	**1,053**	**#DIV/0!**	**1,135**
Central Oil Use (gallons), Winter (Q43)	**Average**	**Per Equipped Household**	**805**	**875**	**749**	**883**	**781**	**#DIV/0!**	**818**
Central Oil, Portable Heater Daily Use Profile, Winter (Q50)	# Obs	Daytime	2	0	2	3	0	0	7
	# Obs	Evening	0	2	0	1	0	0	3
	# Obs	Day&Eve	70	9	39	69	16	0	203
	# Obs	Weekend	0	0	1	3	1	0	5
	# Obs	Eve&WkEnd	0	1	6	2	3	0	12
	# Obs	Occasional	4	1	2	3	2	0	12
	# Obs	Not Using	1	0	0	2	2	0	5
	# Obs	Unknown	0	0	1	1	1	0	3
	# Obs	N/A	9	8	10	18	3	1	49
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	77	13	50	83	24	0	247
	% Obs	**Daytime**	**2.6%**	**0.0%**	**4.0%**	**3.6%**	**0.0%**	**0.0%**	**2.8%**
	% Obs	**Evening**	**0.0%**	**15.4%**	**0.0%**	**1.2%**	**0.0%**	**0.0%**	**1.2%**
	% Obs	**Day&Eve**	**90.9%**	**69.2%**	**78.0%**	**83.1%**	**66.7%**	**0.0%**	**82.2%**
	% Obs	**Weekend**	**0.0%**	**0.0%**	**2.0%**	**3.6%**	**4.2%**	**0.0%**	**2.0%**
	% Obs	**Eve&WkEnd**	**0.0%**	**7.7%**	**12.0%**	**2.4%**	**12.5%**	**0.0%**	**4.9%**
	% Obs	**Occasional**	**5.2%**	**7.7%**	**4.0%**	**3.6%**	**8.3%**	**0.0%**	**4.9%**
	% Obs	**Not Using**	**1.3%**	**0.0%**	**0.0%**	**2.4%**	**8.3%**	**0.0%**	**2.0%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Portable Heater Fuel Type (Q45 & Q46)	# Obs	Fuel Oil - Yes	1	1	2	1	1	0	6
	# Obs	Fuel Oil - No	1	0	1	3	0	0	5
	# Obs	Kerosene - Yes	1	1	2	1	0	0	5
	# Obs	Kerosene - No	1	0	1	3	1	0	6
	# Obs	Unknown	0	0	0	1	0	0	1
	# Obs	N/A	84	20	58	97	27	1	287
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	2	1	3	4	1	0	11
	% Obs	**Fuel Oil**	**50.0%**	**50.0%**	**50.0%**	**50.0%**	**100.0%**	**0.0%**	**54.5%**
	% Obs	**Kerosene**	**50.0%**	**50.0%**	**50.0%**	**50.0%**	**0.0%**	**0.0%**	**45.5%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Portable Heater Fuel Use (gallons), Annual (Q47)	**Average**	**Per Equipped Household**	**#DIV/0!**	**#DIV/0!**	**20**	**2**	**300**	**#DIV/0!**	**107**
Portable Heater Fuel Use (gallons), Winter (Q48)	**Average**	**Per Equipped Household**	**#DIV/0!**	**#DIV/0!**	**20**	**2**	**300**	**#DIV/0!**	**107**
Direct Vent Heater Fuel Use (gallons), Annual (Q51)	**Average**	**Per Equipped Household**	**700**	**#DIV/0!**	**733**	**403**	**417**	**#DIV/0!**	**493**
Direct Vent Heater Fuel Use (gallons), Winter (Q52)	**Average**	**Per Equipped Household**	**625**	**#DIV/0!**	**633**	**311**	**417**	**#DIV/0!**	**444**
Natural Gas Heating Fuel Cost (dollars), Annual (Q55)	**Average**	**Per Equipped Household**	**$1,950**	**$900**	**n/a**	**$2,717**	**n/a**	**n/a**	**$2,159**
Natural Gas Heating Fuel Cost (dollars), Winter (Q56)	**Average**	**Per Equipped Household**	**$1,700**	**$700**	**#DIV/0!**	**$1,180**	**#DIV/0!**	**$0**	**$1,260**
Municipal Heating Fuel Cost (dollars), Annual (Q61)	**Average**	**Per Equipped Household**	**$2,800**	**$2,000**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**$2,400**
Municipal Heating Fuel Cost (dollars), Winter (Q62)	**Average**	**Per Equipped Household**	**$1,500**	**$1,200**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**$1,350**

TABULATIONS OF FAIRBANKS 2010 HOME HEATING SURVEY

			99701	99703	99705	99709	99712	99775	All
Parameter	Stat	Type	Downtown	Wainwright	North Pole	Airport	Steese	University	All
Planned New or Different Heating within 2 Yrs (Q63)	# Obs	Yes	16	1	10	13	10	0	50
	# Obs	No	69	18	49	87	18	1	242
	# Obs	Unknown	1	2	2	2	0	0	7
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	85	19	59	100	28	1	292
	% Obs	**Yes**	**18.8%**	**5.3%**	**16.9%**	**13.0%**	**35.7%**	**0.0%**	**17.1%**
	% Obs	**No**	**81.2%**	**94.7%**	**83.1%**	**87.0%**	**64.3%**	**100.0%**	**82.9%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Burned More Wood Last Winter (Q65)	# Obs	Yes	6	3	12	14	3	0	38
	# Obs	No	5	2	16	26	7	0	56
	# Obs	Unknown	0	0	1	1	0	0	2
	# Obs	N/A	75	16	32	61	18	1	203
	# Obs	All	86	21	61	102	28	1	299
	# Obs	All With	11	5	28	40	10	0	94
	% Obs	**Yes**	**54.5%**	**60.0%**	**42.9%**	**35.0%**	**30.0%**	**0.0%**	**40.4%**
	% Obs	**No**	**45.5%**	**40.0%**	**57.1%**	**65.0%**	**70.0%**	**0.0%**	**59.6%**
	% Obs	**All With**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**0.0%**	**100.0%**
Fuel Price to Stop Using Wood, $/gal (Q66)	**Mean**	**Per Equipped Household**	**$1.46**	**$1.95**	**$1.74**	**$1.78**	**$2.00**	**$0.00**	**$1.74**
	Minimum	**Per Equipped Household**	**$0.50**	**$1.95**	**$0.85**	**$0.00**	**$1.00**	**$0.00**	**$0.00**
	Maximum	**Per Equipped Household**	**$2.00**	**$1.95**	**$3.51**	**$5.00**	**$3.00**	**$0.00**	**$5.00**
	Std Dev	**Per Equipped Household**	**$0.61**	**#DIV/0!**	**$0.79**	**$1.27**	**$1.00**	**$0.00**	**$1.04**
Wood Stove/Insert Seasoning (months) (Q16)	**Average**	**Month**	**13.0**	**15.0**	**15.3**	**16.5**	**8.3**	**#DIV/0!**	**14.4**
Wood Stove/Insert Moisture Content (%) (Q17)	**% Obs**		**1.00%**	**#DIV/0!**	**7.25%**	**8.33%**	**11.25%**	**#DIV/0!**	**7.88%**